Forest Insect & Disease Leaflet 18

U.S. Department of Agriculture Forest Service

Lodgepole Pine Dwarf Mistletoe

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Lodgepole pine dwarf mistletoe (Arceuthobium americanum Nutt. ex Engelm.) is a native, parasitic, seed plant that occurs essentially through-out the range of lodgepole pine in North America. It is the most damag-ing disease agent in lodgepole pine, causing severe growth loss and increased tree mortality. Surveys in the Rocky Mountains show that the parasite is found in one- to two-thirds of commercial lodgepole pine stands. Recent assess-ments of the effects of lodgepole pine dwarf mistletoe in Montana, Colorado, and Wyoming indicate that the annual loss exceeds 40 million cubic feet (1.1 million m3) per year. Acceptable yields cannot be ex-pected from stands infested when they are young. For example, 100-year-old stands that have been infested for 70 years averaged only 300 cubic feet (8 in') of wood per acre, while healthy stands of the same age on similar sites averaged 2,350 cubic feet (65 in') of wood per acre.

Hosts

In the United States, the principal host of Arceuthobium americanum is lodgepole pine. It is occasionally found on Jeffrey, limber, and ponderosa pines. Engelmann spruce, blue spruce, whitebark pine, and Rocky Mountain bristlecone pine may sometimes be infected. In Canada, the principal hosts are lodgepole pine in British Columbia and Alberta and jack pine from Alberta to Ontario. In British Columbia, the parasite has also been found on shore pine, which is the low-elevation subspecies of lodgepole pine along the Pacific Coast. it has not been reported on this tree in the United States.

Figure 1 shows the distribution of lodgepole pine dwarf mistletoe in North America

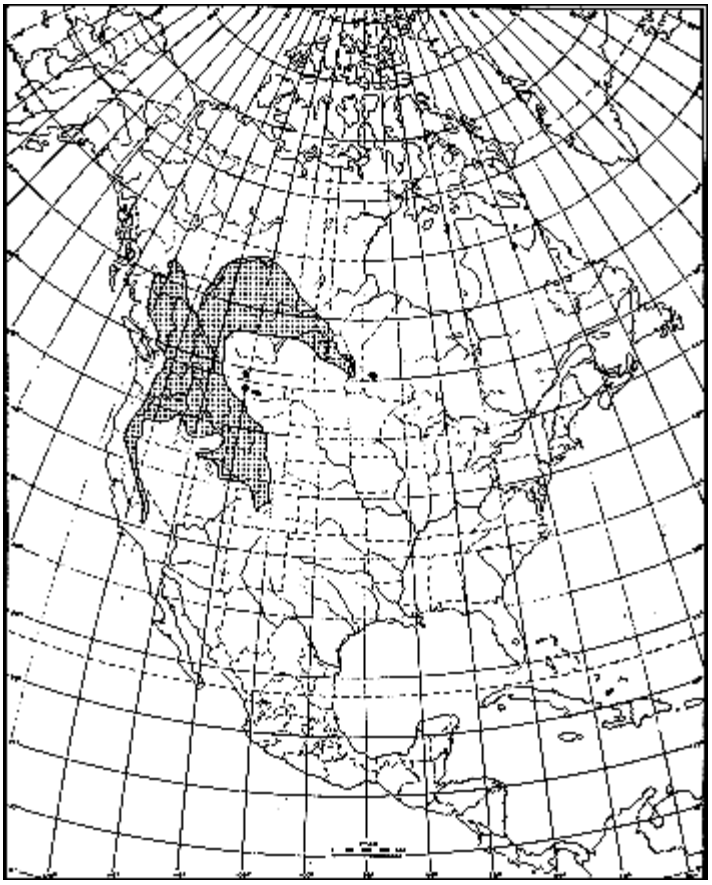
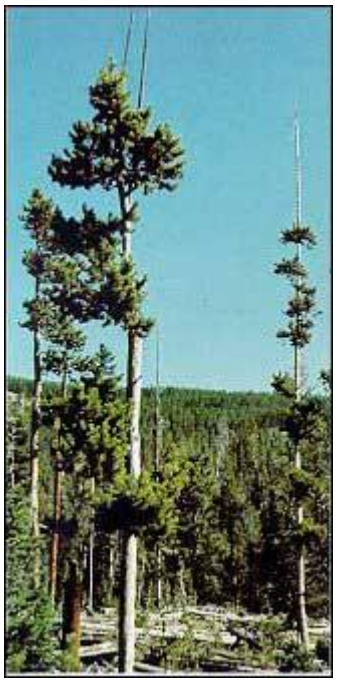


Figure 1 - *Distribution of* Arceuthobium americanum in *North America*.



Appearance of Stands

Recently infested stands show few abnormalities except swellings and inconspicuous dwarf mistletoe shoots on branches and main stems.

Where the parasite has been present for a long time, the stand will have several groups of heavily damaged trees surrounded by increasingly healthier zones of trees. Affected trees are characterized by abnormally tufted branches. These growths, which are caused by the dwarf mistletoe, are called witches' brooms. (See cover photo.) Brooms of another type-stimulation brooms-are frequently mistaken for those caused by dwarf mistletoe. Stimulation brooms are usually denser than dwarf mistletoe brooms (fig. 2). They occur in formerly suppressed trees or trees with dead or broken-out tops and are most common in residual trees left in cutover areas.

Figure 2 *Stimulation brooms, frequently mistaken for those caused by dwarf mistletoe.*

Damage

Older trees with well-developed, vigorous crowns may not show appreciable effects from the parasite for years after initial infection. As the parasite spreads through the crown, however, the tree's growth slows; eventually the crown dies and then the tree. Insects, particularly secondary bark beetles, frequently invade heavily infected trees and kill them.

Dwarf mistletoe also reduces seed production of the host trees and can cause commercially unacceptable deformities such as cankers and knots (fig. 3). Wood quality is also adversely affected.

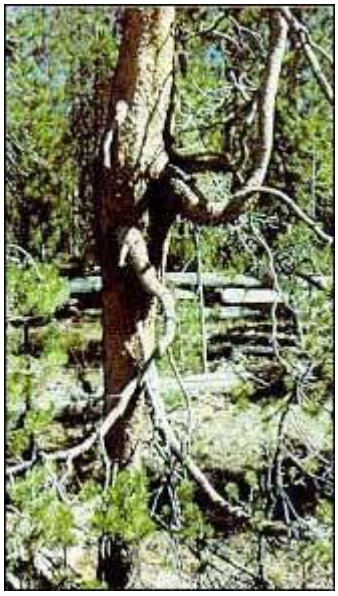


Figure 3-*Heavy dwarf mistletoe infection has distorted the trunk of this lodgepole pine*

Growth losses attributed to dwarf mistletoe are related to the degree of infection, and a six-class system for rating dwarf mistletoe intensity has been devised (fig. 4). Using the dwarf mistletoe rating system, the crown is visually divided into thirds. Each third is given a rating: 0 for no infection, 1 for light infection (less than half the branches infected), and 2 for heavy infection (more than half the branches infected). The ratings for each third are then added to obtain a tree rating. A tree heavily infected in each third would be rated class 6. The ratings of all live trees are averaged to obtain a stand rating, which can be used to estimate net volume growth per acre (table 1). This information is also used to make management decisions, such as when to plan thinnings or harvest cuttings in infested stands.

Life Cycle

Dwarf mistletoe is a parasitic seed plant. On the host tree's stem and branches, it produces slender, leafless, jointed shoots, which are olive-green to yellow in color. The principal function of these shoots is reproduction. The plants are about half male and half female. The plants flower in the spring (March-June) (fig. 5). The flowers, which are pollinated by insects and wind, mature in about 15 months.

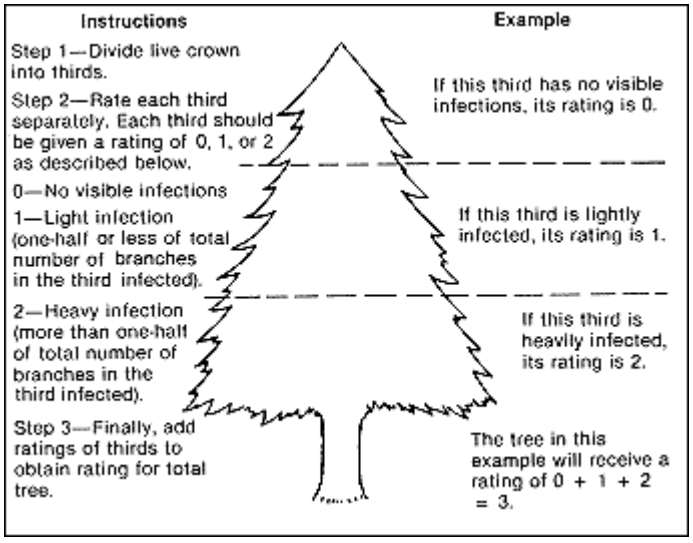

Instructions
Example
Step 1—Divide live crown into thirds.
Step 2—Rate each third separately. Each third should be given a rating of 0, 1, or 2 as described below.
0—No visible infections
1—Light infection (one-half or less of total number of branches in the third infected).
2—Heavy infection (more than one-half of total number of branches in the third infected).
Step 3—Finally, add ratings of thirds to obtain rating for total tree.
If this third has no visible infections, its rating is 0.
If this third is lightly infected, its rating is 1.
If this third is heavily infected, its rating is 2.
The tree in this example will receive a rating of 0 + 1 + 2 = 3.

Figure 4-*Instructions and example of the use of six-class mistletoe rating system.*

Only the female plant bears the fruits that spread the disease (fig. 6).

Each berry-like fruit contains a single seed. At maturity, the elastic outer case of the fruit, which is under high hydrostatic pressure, breaks from its base, contracts violently, and shoots the seed into the air (figs. 7 and 8). The seeds travel at speeds of up to 60 miles (100 km) per hour. They can reach distances of up to 30 feet (9 m), but most seeds fall within 10 to 15 feet (3-5 m) of the source tree. The dispersalperiod is usually limited to about 3 weeks from late August to mid-September, although the period varies with the location and elevation.

Table 1*-Comparative effects of dwarf mistletoe intensity on volume growth based on average site conditions in the Rocky Mountains*

Average stand dwarf mistletoe rating	Mean net annual volume growth per acre
0	30
0.1 to 1.0	30
1.1 to 2.0	29
2.1 to 3.0	25
3.1 to 4.0	19
4.1 to 5.0	4
5.1 to 6.0	-24

A sticky substance (viscin) surrounds each seed and holds it fast to its landing surface. when seeds land on pine needles and the viscous coating is moistened by rain, the seeds slide down the needles.some may be lost, but many are successfully transferred to the twigs. In the spring, the seeds that settled on twigs germinate, establish their root system in the bark, and start new infections. An incubation period of at least 3 to 5 years must elapse before the first shoots are produced (fig. 9).

The shoots bear the flowers and fruits, but synthesize little food. The parasite gathers nourishment through the network of absorbing strands within the pine's cortex and xylem (fig. 10).

Dispersal

Dwarf mistletoe spread depends primarily on the explosive force of the fruits. The presence of isolated infection centers, however, implicates birds or mammals in the dispersal of the parasite for long distances.

Dwarf mistletoe spreads at a rate of about I to 2 feet (0.3-0.6in) per year through single-storied stands. The rate is more rapid in open than in dense stands. Similarly, it spreads faster in multistoried stands than in single-storied stands. The most rapid spread is from an open overstory to a vigorous understory.

Studies made in regenerated clearcuts in the Rocky Mountains (mainly in stands 10 to 25 years old) showed that 89 percent of the infected trees were within 30 feet (9 m) of the residual stand and 98 percent within 40 feet (12 in). Although about 85 percent of the young stands adjacent to infected overstory trees were infected before they were 10 years old, only a

very small proportion of the trees were infected. Infection, however, increased rapidly in stands over 15 years old. Between ages 15 and 30, the percentage of infected trees essentially doubled each 5 years.

Figure 5-*Male dwarf mistletoe plant in (spring) Note the three- or four-parted flowers with anther on each segment.*

Figure 6-*Female dwarf mistletoe plant with nearly mature fruite on bole of lodgepole pine sapling.*

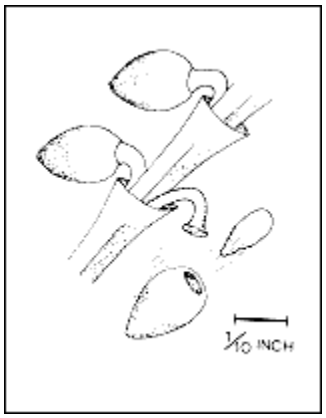


Figure 7-*Diagram of mature dwarf mistletoe fruit and fruit just discharging its seed*.

Ecology

Dwarf mistletoe development depends directly on the vigor of the host tree: the more vigorous the tree, the more vigorous the mistletoe. On good sites with vigorous hosts, the proportion of trees infected is higher than on poor sites, although the effects of the parasite are less on better sites.

As yet, little information is available on the distribution and intensity of dwarf niistletoe in various lodgepole pine habitats. In western Wyoming and southeastern Idaho, lodgepole pine dwarf mistletoe occurs more frequently in the subalpine fir-grouse whortleberry habitat type than in the Douglas-fir-pine grass habitat type. In the Medicine Bow National Forest in southeastern Wyoming, dwarf mistletoe is most common in stands that have a high proportion of grouse whortleberry ground cover; stands that have high coverage of elk sedge generally have less dwarf mistletoe.

Surveys indicate that *Arceuthobium americanum* generally occurs twice as frequently on ridges or hillsides than on bottom sites, apparently because of microclimatic effects.

In the Rocky Mountains, dwarf mistletoe is not found in a 300- to 500-foot (90-150 m) zone just below the upper elevational limits of

Figure 8-*Expulsion of dwarf mistletoe seed.*

the commercial lodgepole pine type. The upper limit of mistletoe ranges from about 9,200 feet (2,800 m) in northern Wyoming to nearly 11,000 feet (3,350 m) in central Colorado.In some areas, much of the commercial lodgepole pine lies in this dwarf mistletoe-free zone. The altitude limit for the mistletoe may be related to the short growing season, which is not long enough for the fruit to mature before severe frosts in the fall.

Fire affects dwarf mistletoe distribution. Partial burns that leave an open, infested overstory create an ideal situation for rapid infection of the regenerated stand. But large, complete bums can eliminate or greatly reduce the parasite, so it is of no further economic consequence in subsequent, regenerated stands. After a complete bum, dwarf mistletoe slowly invades the new stand from infected trees along the edges of the burn.

Control

Clearcutting is the best way to control dwarf mistletoe in mature lodgepole pine. All infected trees should be cut, or the sanitation value of the operation will be lost.

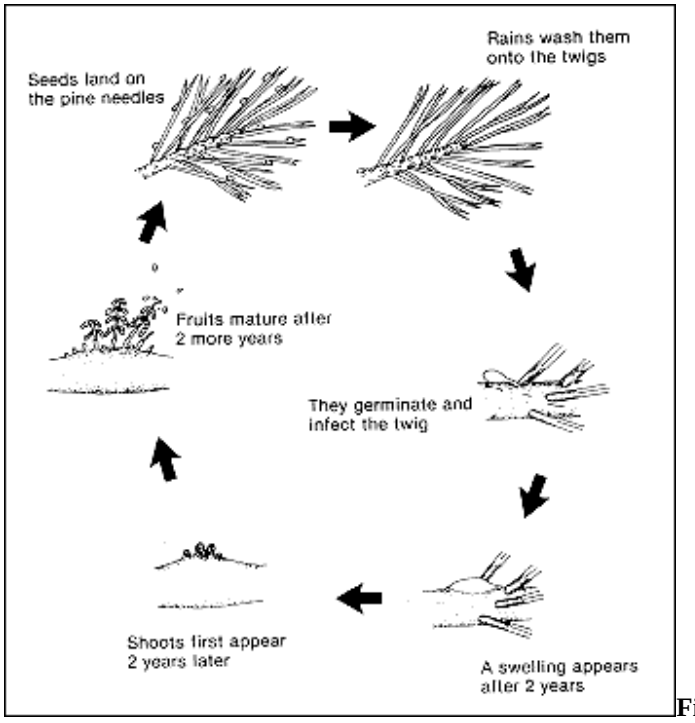

Rains wash them onto the twigs
Seeds land on the pine needles
Fruits mature after 2 more years
They germinate and infect the twig
Shoots first appear 2 years later
A swelling appears after 2 years

Figure 9- *Diagram of the typical lodgepole pine dwarf mistletoe life cycle from seed dispersal to mature plants*

Clearcut units should have a low ratio of perimeter to area (fig. 11). Units should have a regular shape and be larger than 20 acres (8 ha). Narrow strips should be avoided.

Cutting boundaries should be located in bottoms rather than on ridges and should pass through uninfected stands and natural or artificial openings where possible.

Even where stands are properly clearcut, some infection will develop in the regeneration bordering infected areas.

Damage to the young stand will be relatively fight if the residual blocks are cut within 10 years after the new stand is established.

In the past, partial cutting in dwarf mistletoe-infested stands has resulted in large acreages of heavily infested, uneven-aged stands: partial cutting in uneven-aged stands generally produces ideal conditions for rapid rnistletoe spread.

Partial cutting is feasible in some infested, old-growth lodgepole pine stands, but timing of the final harvest cut is critical. The initial cut should be heavy enough to encourage regeneration. To minimize infection in the new reproduction, the final overstory cut should be made within 10 to 15 years, or before the reproduction is about 3 feet (1 m) high. If the infested overstory is left until the reproduction is larger, high infection levels in the reproduction could develop.

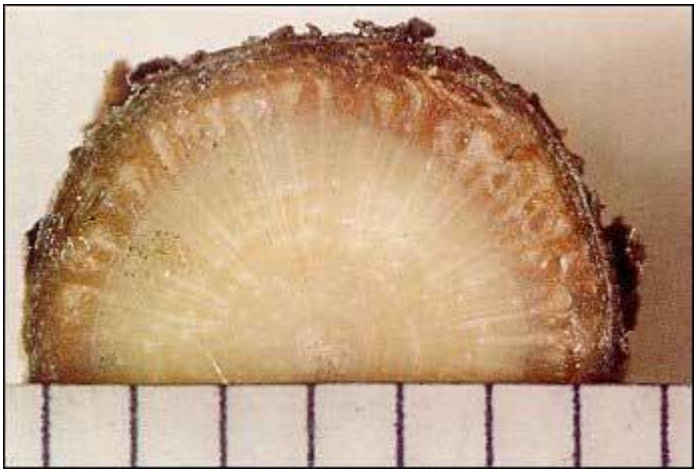


Figure 10 *- Cross section of a lodgepole pine stem showing the parasite's root system in the bark and wood.*

Whether thinnings are feasible in mistletoe-infested lodgepole pine stands depends on several factors, including intensity of infection, site index, stand density, and stand age. As a general rule, thinning is recommended only in stands where infection is not too heavy-that is, stands with mistletoe ratings of 2 or less. At this intensity, about two-thirds of the trees are infected. Thinning should concentrate on cutting the most heavily infected trees. Thinning will usually not significantly increase yields in stands with average mistletoe ratings of over 2.

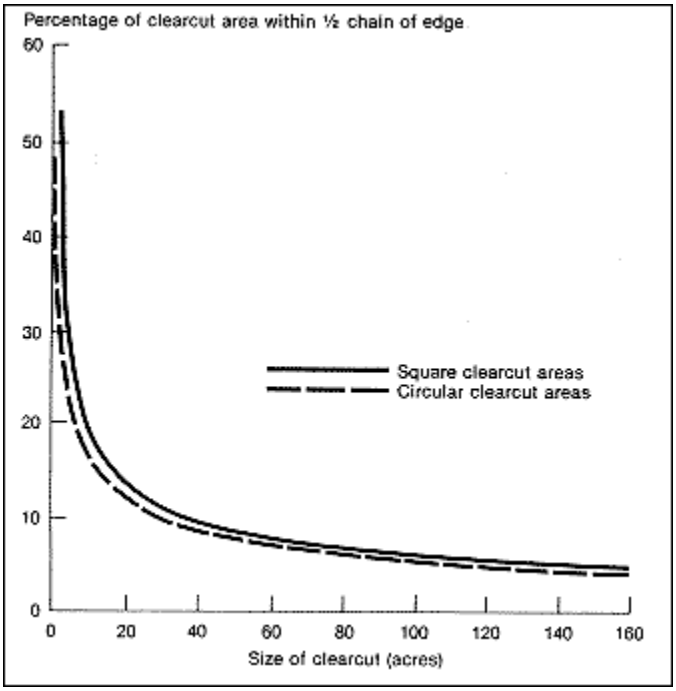


***Figure 11**-Relationship of clearcut size to area within 1/2 chain (33 feet or 10m) of the edge, which is the mistletoe seed-dispersal range from adjacent, infected trees.*

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The Rocky Mountain yield (RMYLD) computer program for preparing simulated yield tables for infested stands can help determine which treatment (clearcut, partial cut, or thinning) will produce optimum yields. With the RMYLD program, it is possible to compare the predicted yields for a given stand under various management alternatives (thinning levels, cutting cycles, or rotation ages). Also, infested and healthy stands can be compared to determine the potential growth rates of the site.

Where lodgepole pines are of high value, as in recreational areas and home sites, infected branches may be pruned to save lightly infected trees. Before trees are pruned, any heavily infected trees nearby should be removed. When trees are pruned, all living branches up to two or more whorls above the highest visibly infected branch should be removed. The trees should be inspected within 3 to 5 years and pruned again, if needed.

Trees that have more than half of their crowns infected should not be pruned. Likewise, trees should not be pruned if branch infections have already reached a part of the trunk that measures 5 inches (13 cm) or less.

If an infection on a branch is close to the bole, the infection may have already reached the trunk. As a rule, the infection has reached the trunk if (1) branches are under 2 inches (5 cm) in diameter and the nearest mistletoe shoots are less than 4 inches (10 cm) from the bole or (2) branches

are over 2 inches in diameter and the nearest mistletoe shoots are less than 5 inches (13 cm) from the bole.

Bole infections can be treated by periodically knocking off the mistletoe shoots and are not necessarily a reason for cutting the tree. Bole infections, particularly on parts of the bole over 5 inches (13 cm) in diameter, have little effect on tree growth; and since the plants produce very few seeds, the infections are not significant in spreading the parasite. Bole infections, however, can distort the trunk and cause commercially unacceptable deformities. (See fig. 3.)

No effective chemical or biological controls have been developed for the dwarf mistletoes. Even if they were available, proper forest management would still be necessary to control dwarf mistletoe in lodgepole pine stands.

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Pesticides used improperly can be injurious to human beings, animals, and plants. Follow the directions and heed all precautions on labels. Store pesticides in original containers under lock and key - out of the reach of children and animals - and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides where there is danger of drift when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts, wear protective clothing and equipment, if specified on the label.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing remove clothing immediately and wash skin thoroughly.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the U.S. Environmental Protection Agency, consult your local forest pathologist, county agriculture agent, or State extension specialist to be sure the intended use is still registered.

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